UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/735,121	12/12/2003	Rajiv K. Mongia	42P18072	1933

8791 7590 09/20/2005

BLAKELY SOKOLOFF TAYLOR & ZAFMAN
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CA 90025-1030

EXAMINER	
HOFFBERG, ROBERT JOSEPH	
ART UNIT	**PAPER NUMBER**
2835	

DATE MAILED: 09/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/735,121	MONGIA ET AL.
	Examiner	Art Unit
	Robert J. Hoffberg	2835

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Specification

1. The disclosure is objected to because of the following informalities: Para. 0027, line 6, "310" should be corrected to "330" for the intermediate power density.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claim 1, 3, 5-8, 10, 11, 15 and 25 are rejected under 35 U.S.C. 102(b) as being anticipated by Wang (US 6,118,656).

With respect to claim 1, Wang teaches that a device, comprising: an integrated circuit chip (Fig. 1, #12); and channels (Fig. 5, gaps between fins 146a, 146b and 146c) to carry a coolant that are proximate to a surface (Col. 3, line 38 mounted adjacent) of the integrated circuit chip and that extend along a length of the integrated circuit chip, wherein a density of the channels (Fig. 5, gaps between fins 146a, 146b and 146c represented by d_1, d_2 and d_n, see Col. 3, lines 60+) changes across the length of the integrated circuit chip or across a width of the integrated circuit chip.

With respect to Claim 3, Wang further teaches that a heat exchange layer over the integrated circuit chip (Fig. 1, #12), wherein the channels (Fig. 5, gaps between fins 146a, 146b and 146c) are formed in the heat exchange layer (Fig. 4, #44).

With respect to Claim 5, Wang further teaches an interface layer (Col. 1, line 14 thermal plate) between the integrated circuit chip (Fig. 1, #12) and the heat exchange layer (Fig. 4, #44).

With respect to claim 6, Wang further teaches the channels include: a first area (Fig. 5, #146a) having a first channel density, and a second area (Fig. 5, #146c) adjacent to the first area and having a second channel density that is lower than the first channel density.

With respect to claim 7, Wang further teaches at least one of the first and second areas span a full width (air flows across Fig. 3, #30a and #30b) of the integrated circuit chip (Fig. 1, #12).

With respect to claim 8, Wang further teaches the channels further include: a third area (Fig. 5, 136b) adjacent to the second area (Fig. 5, #136c) having a third channel density that is different than the second channel density.

With respect to claim 10, Wang teaches a device, comprising: a semiconductor base (Fig. 1, #12) including an area of higher power density and an area of lower power density; and a heat exchange layer (Fig. 4, #44) over the semiconductor base and including channels formed therein suitable for carrying coolant, wherein a density of the channels (Fig. 5, #146a) over the area of higher power density is higher than a density of the channels (Fig. 5, #146b) over the area of lower power density.

With respect to claim 11, Wang further teaches a device comprising a thermal interface layer (Col. 1, line 14 thermal plate) between the semiconductor base (Fig. 1, #12) and the heat exchange layer (Fig. 4, #44).

With respect to claim 15, Wang further teaches a the semiconductor base (Fig. 1, #12) includes an area having an intermediate power density that is between the higher power density and the lower power density, and wherein a density of the channels (Fig. 5, #146c) over the area having the intermediate power density is higher than the density of the channels (Fig. 5, #146b) over the area of lower power density and is lower than the density of the channels (Fig. 5, #146a) over the area of higher power density

With respect to claim 25, Wang teaches a system, comprising: a semiconductor device (Fig. 1, #12) including arteries (Fig. 5, #146a, #146b and #146c) therein suitable for carrying coolant through the semiconductor device, a density of the arteries (Fig. 5 #146a) across a first portion of the semiconductor device being greater than a density of the arteries (Fig. 5, #146b) across a second portion of the semiconductor device; and a fan (Col. 1, line 21) to assist in dissipating heat from the semiconductor device.

4. Claim 19 and 22 are rejected under 35 U.S.C. 102(b) as being anticipated by Nelson et al. (US 4,953,634).

With respect to claim 19, Nelson et al. teaches a device, comprising: an integrated circuit chip (Fig. 1B, #24) including channels (Fig. 1B, #34) in a surface thereof; and a cap (Fig. 1B, #26) connected to the integrated circuit chip to define a top of the channels, wherein an average width of the channels (Fig. 6, #28e on bottom to #30e on top) substantially changes at least once along a length of the channels.

With respect to claim 22, Nelson et al. teaches a device, comprising device of claim 19, wherein an average width of the channels (Fig. 6, #28e to 30e) substantially

changes at least twice along a length of the channels (Fig. 6, the width of the channels is constantly changing along the length of each channel).

5. Claim 29 and 30 are rejected under 35 U.S.C. 102(b) as being anticipated by Chrysler et al. (US 4,765,397).

With respect to claim 29, Chrysler et al. teaches a device, comprising: an integrated circuit chip (Col. 1, line 44 chip); and channels (Fig. 5 and Col. 6, lines 58, formed by channels #60, #61 and #62) to carry a coolant that are proximate to a surface of the integrated circuit chip and that extend along a length of the integrated circuit chip, wherein the channels are longitudinally offset (channel sets formed by #60 and #61) at least once along the length of the integrated circuit chip. See also Ognibene et al. (US 6,273,186) and Azar et al. (US 5,304,846) for staggering or alternating of fin locations.

With respect to claim 30, Chrysler et al. further teaches wherein the channels are longitudinally offset at least twice (Fig. 5, channel sets formed by #60, #61 and #62) along the length of the integrated circuit chip.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claim 2, 4, 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US 6,118,656) as applied to claim 1 above, and further in view of Tuckerman et al. (US 4,450,472).

With respect to Claim 2, Wang teaches the device in Claim 1. Wang does not teach the channels are formed in the integrated circuit chip and substantially under the surface of the integrated circuit chip. Tuckerman et al. teaches the channels (spaces between fins, Fig. 2, #14) are formed in the integrated circuit chip (Fig. 2, #10) and substantially under the surface (Fig. 2) of the integrated circuit chip. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang with that of Tuckerman et al. for the purpose of incorporating the etching of the channels into the integrated circuit chip to improve heat dissipation.

With respect to Claim 4, Wang teaches the device in Claim 3. Wang does not teach a cap on the heat exchange layer to at least partially define the channels. Tuckerman et al. teaches a cap (Fig. 2, #20) on the heat exchange layer (Fig. 4, #44) to at least partially define the channels. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang with that of Tuckerman et al. for the purpose of adding a cap to create a chamber to flow a coolant to improve the heat dissipation.

With respect to Claim 12, Wang teaches the device in Claim 11. Wang does not teach a plate on the heat exchange layer to at least partially define the channels. Tuckerman et al. teaches a plate (Fig. 2, #20) on the heat exchange layer (Fig. 4, #44) to at least partially define the channels. It would have been obvious to one of ordinary

skill in the art at the time of the invention was made to modify the device of Wang with that of Tuckerman et al. for the purpose of adding a cap to create a chamber to flow a coolant to improve the heat dissipation.

With respect to Claim 14, Wang teaches the device in Claim 10. Wang does not teach wherein the channels over the area of higher power density include at least two staggered segments. Tuckerman et al. teaches wherein the channels over the area of higher power density include at least two staggered segments (Fig. 4, discontinuity of #36). It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang with that of Tuckerman et al. for the purpose of interrupting the longitudinal fins for to improving air flow to increase heat dissipation.

7. Claim 13 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US 6,118,656).

With respect to Claim 13 and 26, Wang teaches the device in Claim 10 or the system in Claim 25, respectively. Wang does not teach a density ratio of the channels or arteries. While Wang fails to disclose the specific ratio, it is obvious that a ratio of high power channels or arteries exists as seen in Fig. 5. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to include a density ratio of greater than 1.1 or any ratio which would allow the device or system to operate at maximum efficiency.

8. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US 6,118,656) as applied to claim 1 above, and further in view of Ognibene et al. (US 6,273,186).

With respect to Claim 9, Wang teaches the device in Claim 6. Wang does not teach that the channels are longitudinally offset at least once within the first area. Ognibene et al. teaches wherein the channels are longitudinally offset (Fig. 3A, staggered rows of #302) at least once within the first area. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang with that of Ognibene et al. for the purpose of staggering or alternating rows of fins for to improve air flow to increase heat dissipation.

9. Claim 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US 6,118,656) as applied to claim 1 above, and further in view of Shibasaki (US 6,223,815).

With respect to claim 16, Wang teaches the device in Claim 10. Wang does not teach a second heat exchange layer over another heat exchange layer. Shibasaki teaches an upper heat exchange layer (Fig. 3, #26) over the heat exchange layer (Fig. 3, #27) and including upper channels (Fig. 3, #92) formed therein suitable for carrying coolant. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang with that of Shibasaki for the purpose of improving heat dissipation by adding additional heat exchange layers.

With respect to claim 17, Wang and Shibasaki teach the device in Claim 16. They do not teach that the density the channels vary over different power densities.

Wang further teaches that a density of the upper channels (Fig. 5, #146a) over the area of higher power density is higher than a density of the upper channels (Fig. 5, #146b) over the area of lower power density. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang and Shibasaki with further embodiments of Wang to vary the density of the upper channels according to the different power densities to improve heat dissipation.

10. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US 6,118,656) and Shibasaki (US 6,223,815) as applied to claim 16 above, and further in view of Suzaki (US 6,466,441).

With respect to claim 18, Wang and Shibasaki teach the device in Claim 16. They do not teach that the orientation of the channels. Suzuki further teaches the direction of the channels (Fig. 5, #115c) in the heat exchange layer is substantially orthogonal to a direction of the upper channels (Fig. 5, #115d) in the upper heat exchange layer. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Wang and Shibasaki with that of Suzuki to arrange the channels two dimensionally to increase the heat dissipation.

11. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson et al. (US 4,953,634).

With respect to Claim 20, Nelson et al. teaches the device in Claim 19. Nelson et al. does not teach a ratio of the average width of the channels. While Nelson et al. fails to disclose the specific ratio, it is obvious that a ratio of higher average width to lower average width channels exists as seen in Fig. 6. It would have been obvious to one of

ordinary skill in the art at the time of the invention was made to include an average width ratio of less than 8 or any ratio which would allow the device to operate at maximum efficiency. See Wang (US 6,118,656) wherein the individual channels widths are constant, but different sets of channels have different average widths.

12. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson et al. (US 4,953,634) as applied to claim 19 above, and further in view of Chrysler et al. (US 4,765,397).

With respect to Claim 21, Nelson et al. teaches the device in Claim 19. Nelson et al. does not teach a discontinuity in the lower average width channel area. Chrysler et al. does teach the channels (Fig. 5, #50 described in description as #60) within the area of lower average width include at least one discontinuity. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Suzaki with that of Chrysler et al. to improve heat dissipation. See Bhatti et al. (US 6,422,307 abstract, lines 7-9) for restricting the length of the fins to yield a higher rate of heat dissipation.

13. Claim 23 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson et al. (US 4,953,634) as applied to claim 19 above, and further in view of Suzaki (US 6,466,441).

With respect to Claim 23, Nelson et al. teaches the device in Claim 19. Nelson et al. does not teach a second heat exchange layer over the cap including upper channels. Suzuki teaches a heat exchange layer over the cap and including upper channels (Fig. 9B, #115D) formed therein suitable for carrying coolant. Nelson et al. further teaches

average width of the upper channels (Fig. 6, #28e to #30e) substantially changes at least once along a length of the upper channels. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Nelson et al. with that of Suzuki to add a second heat exchange layer with varying average channel width to increase the heat dissipation.

With respect to Claim 24, Nelson et al. and Suzuki teaches the device in Claim 23. Nelson et al. does not teach the orthogonal relationship between the two sets of channels. Suzuki further teaches the direction of the length of the channels (Fig. 9B, #115c) in the integrated circuit chip is substantially orthogonal to a direction of the length of the upper channels (Fig. 9B, #115d) in the heat exchange layer. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Nelson et al. and Suzuki with further that of Suzuki to arrange channels in a two dimensional pattern to increase the heat dissipation.

14. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tuckerman et al. (US 4,450,472) in further in view of Wang (US 6,118,656).

With respect to claim 27, Tuckerman et al. teaches a method, comprising: forming first channels (Fig. 1, #12 upper side) in a layer of a semiconductor device (Fig. 1, #10); forming second channels (Fig. 1, #12 lower side) in the layer of a semiconductor device adjacent to the first channels and in a same direction as the first channels. Tuckerman also teaches capping (Fig. 2 #20) the first and second channels to form a channel structure suitable for carrying liquid coolant through the semiconductor device. Tuckerman does not teach varying the width of the channels.

Wang teaches that the second channels (Fig. 5, #146a) having a greater average width than the first channels (Fig. 5, #146b). It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Tuckerman et al. with that of Wang to vary the width of the channels to increase the heat dissipation.

15. Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tuckerman et al. (US 4,450,472) and Wang (US 6,118,656) in further in view of Schmidt (US 3,658,584).

With respect to claim 28, Tuckerman et al. and Wang teach the method of claim 27. Tuckerman and Wang do not teach the materials of the semiconductor device. Schmidt teaches that the layer of the semiconductor device includes copper, aluminum, or silicon (Col. 5, lines 31-44). It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Tuckerman et al. and Wang with that of Schmidt to fabricate the semiconductor device out of any of numerous different materials.

16. Claim 31 is rejected under 35 U.S.C. 102(b) as being unpatentable over Chrysler et al. (US 4,765,397) in further in view of Ognibene et al. (US 6,273,186).

With respect to claim 31, Chrysler et al. teaches the method of claim 29. Chrysler et al. does not teach the substantially uniform density along the length of the integrated circuit. Ognibene et al. teaches the substantially uniform density along the length of the integrated circuit. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Chrysler et al. with that

of Ognibene et al. alternate or stagger the uniform density channels across the length of the integrated circuit to increase the thermal performance of this method.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Robert J. Hoffberg whose telephone number is (571) 272-2761. The examiner can normally be reached on 8:30 AM - 4:30 PM Mon - Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynn D. Feild can be reached on (571) 272-2092. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

***

LYNN FEILD
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800